

# The Green Knowledge Society

This document is intended to provide inspiration regarding the role of the green industries and the life sciences in Sweden's progress towards a sustainable society. It has been produced in good time for the 2008 research policy bill by the organisations listed below, headed by the Royal Swedish Academy of Agriculture and Forestry.

## SUMMARY VERSION



Swedish Energy Agency • The Swedish Research Council Formas • Swedish National Rural Development Agency • GRO Green sector federation • The Rural Economy and Agricultural Societies • JTI Swedish Institute of Agricultural and Environmental Engineering • The Swedish Board of Agriculture • National Chemicals Inspectorate • Federation of Swedish Farmers • Lantmännen Food R&D • The Swedish Institute for Food and Agricultural Economics • The Swedish Food Federation • The National Food Administration • LRF Forestry Owners • The Foundation for Strategic Environmental Research • The Forestry Research Institute of Sweden • Skogssällskapet • The National Veterinary Institute • The Swedish Horse Research Foundation • SP Wood Technical Research Institute of Sweden • Swedish University of Agricultural Sciences • WWF



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## THE GREEN KNOWLEDGE SOCIETY

Research and innovation for a bio-based knowledge society

A vision for the 21<sup>st</sup> century

Those behind the document THE GREEN KNOWLEDGE SOCIETY share, without having taking a position on every single detail in the document, a common understanding:

- That Sweden can and must advance towards becoming a sustainable society.
- That the green industries, by the application of knowledge from the life sciences in particular, have very great potential to contribute actively to the creation of a sustainable society.
- That it is mainly a lack of knowledge and not natural resources that limits the potential for creating a sustainable Sweden.
- It is, therefore, highly unsatisfactory, and disturbing, that society's investments in non-military research have declined over the past five years.
- That the government's goal of devoting one per cent of GDP to publicly financed expansion of knowledge must be regarded as a minimum target.
- That significantly larger resources must be invested in the long term in internationally highly qualified research, above all within the life sciences and research related to this research area.
- That university and college research and research institutions having links to the green industries have an essential role to play in the realisation of this document's vision.
- That advanced basic research, need-motivated research and multidisciplinary research are all needed to tie together the common elements from the humanities, social sciences and other areas of the natural sciences to realise the vision.
- That improved communications, both between different research cultures and research traditions and between research and society, are a crucial strategic issue when it comes to science's potential and that of the green industries to bring about a sustainable Sweden.
- That economics, ecology, ethics, aesthetics and positive emotional support are key concepts in the discussion about the way to a sustainable society.



### The role of the life sciences in society

Spider silk is so strong that a net spun to the width of a finger could bring a Boeing 747 to a halt on landing. A Swedish research team is the first in the world to have succeeded in spinning a thread of spider silk that is more than one and a half metres long – made from micro-organisms.

It is not hard to imagine what usable spider silk, and all the rest of the commercially applicable discoveries from our era's life science research, could mean for the development of a sustainable society, and for new, profitable products and companies. This and numerous other scientifically based visions, as well as the speed, scope, depth and precision of the advances in the biological sciences, lie behind the life sciences' most daringly formulated conviction:

That research within the life sciences will come to have the same degree of importance for society during the 21<sup>st</sup> century as research within physics and chemistry did during the 1900s.

### The role of the Green Industries in society

Sweden, more than many other countries, depends on developments within the biological sciences and the green industries to turn knowledge into products and services. Taken together, two of the green industries (forestry and the food industry) account for almost 15 percent of Sweden's exports. The pharmaceutical industry, which also builds on what we know about and can manage in terms of nature's mechanisms, accounts around 5 percent. The life industries together represent 20 percent of our exports, which may be compared with the telecommunication industry's 13 percent or so. Altogether the green industries employ around 250,000 people. Seventeen percent of the energy consumed by society each year comes from the green sector. Developments within the green industries have significant consequences for the aesthetics of the landscape, its appearance and accessibility, and are therefore of great importance for recreation and outdoor life. The number of horses, for riding, harness racing and racing, is almost 300,000. The horse industry is now agriculture's fifth largest source of income and the turnover within the agriculture sector it accounts for almost 3.5 billion kronor (0.5 billion US\$) per year. How the green industries



use new knowledge is crucial for how they succeed in developing, strengthening and preserving, what are often called ecosystem services, which are crucial for the existence of society and for our ability to live up to most of the 16 environmental quality goals laid down by the government and parliament. Food is the substance that everybody needs every day in order to remain alive. Everybody needs pharmaceuticals at some time. Every day we use products and services that have their origins in, or are connected in some way with Swedish forests and the Swedish forest industry. It is hard to think of any scientific area that has more far-reaching importance for society than the life sciences or any sector of the economy that plays a greater role in society than the green industries.

The ongoing process of climate change and the link to mankind's emissions of greenhouse gases have also put a sharp focus on the green industries, not only as a source of greenhouse gases but also and above all as a source of renewable energy and new raw materials. The green industries have themselves very successfully moved further in the direction of greater sustainability. However they are also dependent on fossil-fuel energy and other resources from non-renewable sources and play a not insignificant role in the over-fertilising of the Baltic Sea.

More and more in-depth bio-medical research, both theoretical and clinical, is resulting in increasingly detailed knowledge about how the substances in and the composition of our foods affect our health. This can be considered from almost every angle, from the mechanisms behind obesity to our cognitive functions. There is much to suggest that our major pandemic diseases, chronic illnesses, and our general ill health are in one or another way associated with the physiological effects of food, its chemical composition and its microbial condition. And this goes far beyond the conditions that are associated with being overweight. The distinction between foodstuffs and pharmaceuticals is on the way to disappearing.

The challenges that the green industries are facing are about increasing the available supply of products from the soil, animals and forests, not least supplying biofuel and raw materials to the chemical/technical industry, and at the same time reducing the environmental impact, preserving, recreating and creating natural values, creating new experiences and new services, radically improving animal welfare, improving the work environment, raising product quality and at the same time reducing production costs.



Within the international research community a conviction is beginning to emerge that this entire equation can be solved by putting plus signs in front of all the variables. The basis for this optimism lies in the detailed and systematic knowledge about how nature itself functions that has developed within the life sciences. **All of nature's variety of colours, forms, functions, materials, mechanisms, characteristics and interdependent forms of life are built from nothing other than what exists in sun and earth, air and water.** Slowly but surely research is mapping the physical, chemical and biological mechanisms that join together the simple basic conditions underlying nature's enormously complex kingdom.

### Biology's resources

Within the biological sciences a paradigm shift is now taking place equivalent to what a series of discoveries, from the end of the 1800s and onwards, within physics and chemistry brought about, discoveries that have now led to our **Globalised Information Society**. The paradigm shift within the life sciences, which began with a series of discoveries from the middle of the 1900s, can now in the 21<sup>st</sup> century lead to the **Green Knowledge Society** of tomorrow. A society in which a steadily growing proportion of the energy, goods and services we need are produced from what can be grown in fields and forests or can be created in what are known as bio mimetic (imitating nature) processes applied on an industrial scale. Things that we can do with high pressure, high temperatures, powerful chemicals and fossil fuels are what Mother Nature, often with greater elegance, does with energy from the sun, raw materials from the soil, air and water using the information that is stored in the cells' DNA.

What is missing in the life sciences' vision of the **Green Knowledge Society** – A Biobased Knowledge Society – is not nature's own resources. For example a surface of around 80 x 80 km covered with solar panels with the currently best known level of efficiency of 12 percent can trap energy that is equivalent to Sweden's total energy requirements. That corresponds the ground that the national road network covers in asphalt today. Nature, in its own highly efficient way, converts sunlight into energy. In the first stage of the green plants' process of photosynthesis almost 40 percent of the captured sunlight is converted into chemically bound energy. However, the amount that eventually remains as part of the plant itself (such as the carbohydrates that we convert into ethanol) is only around 1 percent. That is also why energy from the fields and forests has such a limited potential on a global scale to replace



energy from oil, coal and natural gas. The highly efficient nature of the first step of photosynthesis reflects, however, the great potential that exists for bio mimetic (nature imitating) systems to convert solar energy into hydrogen direct. However, it is rather more realistic to replace oil and coal with raw materials from the field and the forest on a global scale and for Sweden as a nation bioenergy and bio-resources can represent a significant contribution on the way towards an oil-free society.

Sweden's forests, especially those that are not nature reserves or protected, are cultivated forests. Purely virgin or natural forest only exists in very limited areas. The difference between forestry and farming is the long life cycle of trees in the forest, and the fact that they are therefore to a large extent unimproved. In all probability, trees have the same internal biological potential for change as the original agricultural crops that were domesticated 10,000 years ago. Beyond a possible increase in production of several hundred percent this also means there is a possibility of modifying a number of characteristics. Characteristics that are all of importance for the pulp and paper industry, for saw mills, building companies, the chemical industry, and not least for the forest raw materials for use in what is becoming known as second and third generation of bio-fuels.

What also distinguishes open farmland from closed forestlands is that forests during their life cycle have less effect on the surrounding ecosystem. Preparation of the land, sowing seeds and/or planting seedlings are modest measures and there is little need to use chemicals for protection. In the vision that could be outlined if we could cultivate the soil as a "virtual" forest, that is with perennial, resistant crops, most of the heavy machines in the fields would have been completely eliminated, working hours and the need for fuel, fertiliser and chemicals would be radically reduced – or gone altogether. Water and wind erosion from the soil would have fallen dramatically, bio-diversity would have increased, leaching of the soil would be reduced to a "natural" level and farmland would have been transformed into a carbon sink that would absorb and absorb much more carbon dioxide from the atmosphere than the volume it emits.



### Lack of knowledge

What is missing from the life sciences vision of a Green Knowledge Society is not nature's resources – what is missing is scientific knowledge.

It is therefore alarming that the government's contribution to civil research has declined from 0.84 percent of GDP in 2003 to 0.78 percent in 2007 at a same time when government investments in research has increased in competitor countries. We view the government's minimum level of 1 percent of GDP to publicly finance the expansion of knowledge as just a minimum goal and a disturbing one if the aim is not eventually to increase the share of GDP devoted to scientific research. Equally disturbing is not only the fact that only four Swedish universities are ranked amongst the world's 100 top universities but also that they have lost ground in recent years. This is especially disturbing for the green sector and related industries, for several different reasons.

The overall conditions for reaching a sustainable Green Knowledge Society involve radically reducing the need for external physical resources. The commercial forces behind the ability to participate in the process are weak. New knowledge opens up scope for reducing the need for expensive buildings, fittings and machines as well as minimising the need for seeds, fuel, artificial fertiliser and pesticides. Here there are no obvious commercial driving forces to invest in research resources to develop the basic knowledge that is needed to discover the practical applications. However, there would be immense gains to the economy and society at large.

The great benefits to society that applied life sciences can lead to, can probably only be realised if society takes the initiative and formulates long-term goals and if adequate resources are earmarked for the research that is needed to reach that goal.

It is developments in knowledge of logistics and information technology with roots in the 1900s that are currently driving the process of globalisation that more than anything else is having an effect on the green industries' immediate future. This will lead to stiffer competition that is much more market driven for the green industries. The ability to reduce the supply of expensive energy-intensive means of production and at the same time produce higher quality products – as well as being able to offer competitive prices – is crucial if the



green industries are to be able to compete internationally. Sustainable, long-term competitive ability can only be achieved if the green industries at the same time reduce their impact on the environment, increase their consideration for nature and satisfy high ecological, ethical and aesthetic demands that are identified and formulated by science, public opinion and politicians. The growth in international trade, international tourism, and rapidly increasing economies of scale, especially within animal production, are creating totally new conditions when it comes to the spread of different organisms between different ecosystems, infection pressures, paths of infection and spread of infection, of contagious diseases, and also when it comes to infections that can be passed between animals and humans.

None of these challenges can be handled without qualified, domestic research within, for example, economics, veterinary medicine, and the natural and social sciences.

The green industries have their roots in Sweden's forestry and farming districts. All changes that affect these industries are in the final analysis linked with the social lives, demography and business conditions of these districts. The forces driving the trend towards higher returns from the forest and the land also leads to changes in the conditions for the lives of these rural areas. New production methods cause changes in the landscape and different living conditions. There is great potential here but also a source of conflicts of interest that involve economic and business considerations as well as psychosocial and social science knowledge if they are to be realised and controlled.

Throughout the entire chain from the soil to the point when a food product becomes a substance for sustaining life, scientists are discovering more and more details that have great importance for our bodily and spiritual wellbeing. Choice of species, soil, cultivation and feeding methods have an influence on the products' nutritional value and physiological effects. Breeding methods can influence the need for antibiotics in animal husbandry and thus the development of antibiotic resistance within human medicine and also here, the products' nutritional value and physiological effects. Here there is a great need for knowledge, which can only be met by multidisciplinary research which brings together human medical research with research into molecular biological growth, animal research, ethology, bioinformatics and technical research etc.

Given all of these challenges, changes, problems, possibilities that the green industries are facing, research within the life sciences is going to have exceptionally great and crucial importance. The ability to develop environmentally and nature-friendly cultivation systems



within both farming and forestry while at the same time reducing the need for resources and increasing production is, for example, completely dependent on new research in ecological systems and molecular biology that can be applied to plant and tree improvement and new cultivation methods. Furthermore the ability to replace oil with raw materials from farming and forestry depends on new biological knowledge that can be applied to practical improvement processes and cultivation methods. It is therefore exceptionally serious that the entire plant genetic improvement sector in Sweden has lost ground dramatically. It is also exceptionally serious that the development and application of new biological knowledge is advancing significantly faster in, for example, the United States, India, China and Brazil than in Sweden and Europe. Here the state has a particularly great responsibility for ensuring that the Swedish life science research and application can keep up with developments in our competitor countries.

The current process of globalisation in the economy and the trend towards more internationally orientated markets has far-reaching consequences of the entire chain from individual farmers, small sawmills, and food producers to large international groups. Advanced and sophisticated economic research within economics and political science is of crucial importance for rational decision-making across the entire spectrum from individual entrepreneur to where the political decisions that affect these industries are made.

The potential possessed by the life sciences to change society and influence individuals involves both known and unknown risks, major social challenges and prompts numerous questions. Questions that can only be answered with the aid of qualified risk research, and research into the social sciences, sociology, and the behavioural and communication sciences.

### Great social responsibility

Developments within the life sciences have now acquired such a broad, rapid and deep character that it is very difficult for individual scientists, institutions, non-profit or commercial organisations to have an overview of the changes that might occur in society. We can get an idea about the possibility of solving numerous ethical, ecological, economic and aesthetic problems that follow in the wake of the scientific and technical developments that have so far been made within the green industries. On the other hand, what we not



only have an idea about but can also be completely sure of is that the application of the life sciences in the future will also make possible extensive savings for society and business, creating the conditions for developing existing industries and creating countless new services and products, primarily at the international level. Many will be realisable more or less immediately by virtue of their market potential. Others will only be launched on the market in the longer term or only via national or international governmental demands.

It is reasonable and self-evident that society will assume great organisational, political and financial responsibility for realising this potential. Furthermore we can be sure that the developments will result in new ethical, ecological, aesthetic, economic and political conflicts. We can also be sure that no applications will be possible if they are not compatible with the interests and values of financiers and users – landowners and farmers, consumers, taxpayers, politicians and the business community.

We have demonstrated that the green sector has had and still has great importance for the national economy, employment and the sustainability of society. If we wish in the future to consolidate and develop this, and create new green businesses, the state must ensure that significantly more resources are devoted to research and innovation, particularly at such a time as the present, when, whether we like it or not, a paradigm shift is taking place in which biology and life science are beginning, to a greater degree than in the past, to determine the character of tomorrow's society. The nations and enterprises that apply their energies to developing competence and skills, products, services and enterprise based on the green sector will, in a particularly marked way, contribute to the development of a sustainable world society, while also strengthen their competitiveness on the international arena.





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The Royal Swedish Academy of Agriculture and Forestry (KSLA) is a gathering place for the green sector. The Academy is an free and independent network of organisation that are concerned with agriculture, horticulture, foodstuffs, forestry and forest products, fishing, hunting and water use, the environment and natural resources, as well as the history of forestry and farming. We are involved with issues that affect every-one and interest many!